

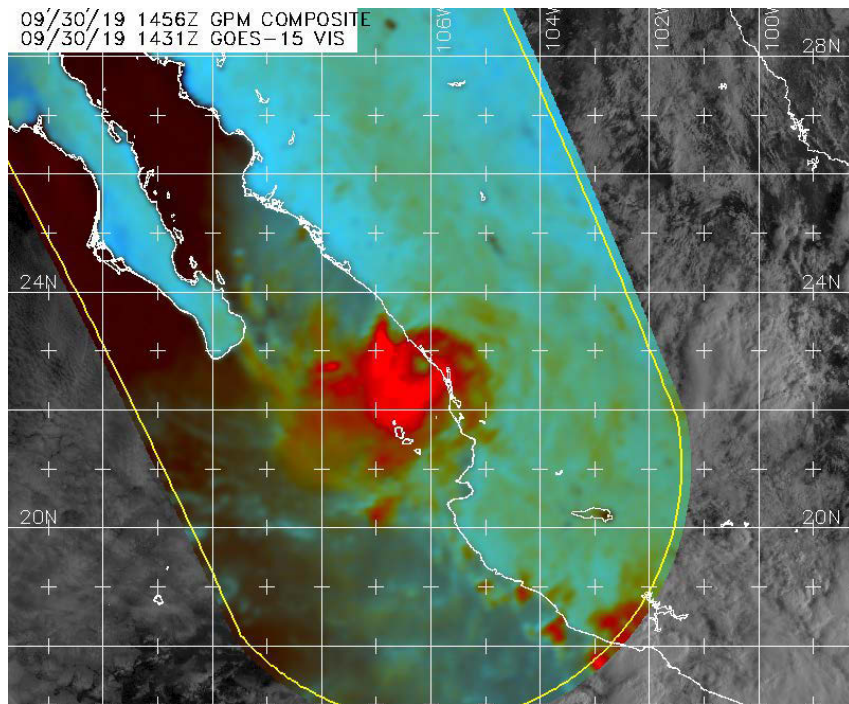


NATIONAL HURRICANE CENTER TROPICAL CYCLONE REPORT

TROPICAL STORM NARDA (EP162019)

29 September–1 October 2019

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National Hurricane Center
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91-GHZ COLOR COMPOSITE GPM IMAGE AT 1456 UTC 30 SEP 2019 (COURTESY OF THE NAVAL RESEARCH LABORATORY).

Narda formed close to the southern coast of Mexico and made landfall as a 40-kt tropical storm just northeast of Lazaro Cardenas. The cyclone emerged southeast of the Gulf of California and re-intensified to 45 kt before its second landfall in northwestern Mexico. Flash floods and mud slides were the main associated impacts, with 6 deaths reported in Mexico.

Tropical Storm Narda

29 SEPTEMBER–1 OCTOBER 2019

SYNOPTIC HISTORY

Narda originated from a tropical wave that departed the west coast of Africa on 15 September. This low-latitude wave moved through the Windward Islands on 23 September, and entered the eastern Pacific on 26 September. The system moved very slowly westward during the next two days and became embedded within the eastern part of a larger Intertropical Convergence Zone (ITCZ) circulation, also described as a Central American Gyre, centered a couple of hundred miles south of southern Mexico and west of Central America. Although the system was very elongated from northeast to southwest, mostly diurnal bursts of thunderstorms occurred during that time, which caused the overall wind circulation to strengthen, with gales noted in scatterometer data on 28 September. Deep convection became more concentrated late that day in the northeastern portion of the surface trough, and a tropical storm formed near 0000 UTC 29 September about 120 n mi south of Acapulco, Mexico. The “best track” chart of Narda’s path is given in Fig. 1, with the wind and pressure histories shown in Figs. 2 and 3, respectively. The best track positions and intensities are listed in Table 1¹.

Narda moved quickly to the northwest over its short lifetime due to a mid-level ridge over central Mexico. The storm slightly strengthened after formation and made landfall with 40-kt winds near 1400 UTC 29 September about 15 n mi northeast of Lazaro Cardenas, Mexico. While the winds near the center weakened due to the mountainous terrain, scatterometer data indicated that tropical-storm-force winds continued along the immediate coast of southwestern Mexico, partially due to the large circulation and orographic effects. Narda moved offshore early the next day and immediately re-intensified, with a mid-level eye noted after the center moved over water (cover image). The storm hugged the coast of Mexico and reached an estimated peak intensity of 45 kt near 1800 UTC 30 September, and made landfall 6 h later at that intensity near Las Glorias. The cyclone then rapidly weakened due to the mountainous terrain and dissipated just after 0600 UTC 1 October over southern Sonora in northwestern Mexico.

METEOROLOGICAL STATISTICS

Observations in Narda (Figs. 2 and 3) include subjective satellite-based Dvorak technique intensity estimates from the Tropical Analysis and Forecast Branch (TAFB), the Satellite Analysis Branch (SAB), objective Advanced Dvorak Technique (ADT) estimates and Satellite Consensus (SATCON) estimates from the Cooperative Institute for Meteorological Satellite Studies/University

¹ A digital record of the complete best track, including wind radii, can be found on line at <ftp://ftp.nhc.noaa.gov/atcf>. Data for the current year’s storms are located in the *bt* directory, while previous years’ data are located in the *archive* directory.

of Wisconsin-Madison. Data and imagery from NOAA polar-orbiting satellites including the Advanced Microwave Sounding Unit (AMSU), the NASA Global Precipitation Mission (GPM), the European Space Agency's Advanced Scatterometer (ASCAT), and Defense Meteorological Satellite Program (DMSP) satellites, among others, were also useful in constructing the best track of Narda.

The 45-kt peak intensity of Narda was based on a blend of lower ASCAT data and much higher SATCON/ADT values. Because of the wide disagreement in the available estimation techniques on 30 September (Fig. 2), this peak intensity has a larger uncertainty than normal. In addition, it is possible that the low-level circulation was disrupted over Mexico for 6–12 h, and Narda degenerated into a trough before it re-generated offshore of western Mexico, but the data were not conclusive for that scenario to be shown in the best track.

Extremely heavy rainfall was a serious problem in southwestern Mexico due to Narda and the large circulation of the ITCZ/Gyre. The peak rainfall report was 15.48 inches in Coloso, Guerrero. In addition, a very large swath of 10–12 inches of rain (Fig. 4) occurred during the 5-day period around Narda's lifetime from near Salina Cruz, in southern Oaxaca near the Gulf of Tehuantepec, westward across almost the whole Pacific coast of southern and southwestern Mexico. These rainfall totals also occurred across much of the west coast of Mexico north of Puerto Vallarta.

Selected surface observations are given in Table 2. A number of sites had tropical-storm-force wind gusts, with the highest value being 45 kt at Puerto Vicente.

There were no credible ship reports of winds of tropical storm force associated with Narda in the eastern Pacific basin.

CASUALTY AND DAMAGE STATISTICS

There were six direct deaths² recorded over Mexico in association with Narda. Two people were reported killed in both Jalisco and Oaxaca, with one death noted in both Colima and Guerrero. Most of these deaths were due to inland freshwater flooding. Across southwestern Mexico, severe flooding and tree and crop damage were reported, along with hundreds of homes being flooded in Tutupec. Roads were washed out by landslides, and people had to be rescued by helicopter in Jalisco. Monetary damage estimates are not available at this time, but are expected to be in the tens of millions of U.S. dollars.

² Deaths occurring as a direct result of the forces of the tropical cyclone are referred to as "direct" deaths. These would include those persons who drowned in storm surge, rough seas, rip currents, and freshwater floods. Direct deaths also include casualties resulting from lightning and wind-related events (e.g., collapsing structures). Deaths occurring from such factors as heart attacks, house fires, electrocutions from downed power lines, vehicle accidents on wet roads, etc., are considered "indirect" deaths.

FORECAST AND WARNING CRITIQUE

The genesis of Narda was very well anticipated (Table 3). A low chance (<40%) of genesis was given 126 h prior to the eventual formation in the 5-day outlook and 78 h prior in the 2-day outlook, and the lead-time in the medium category (40–60% chance) was also quite large (114 and 48 h, respectively). The probabilities reached the high category (>60%) in the 2-day outlook 30 h before genesis. Most of the models had a reasonable representation of Narda due to its large size, although they had some trouble depicting exactly where it would form within the larger ITCZ.

A verification of NHC official track forecasts for Narda is given in Table 4a. Official forecast track errors were considerably greater than the mean official errors for the previous 5-yr period. A homogeneous comparison of the official track errors with selected guidance models is given in Table 4b. Although the official forecast was as good as or better than most of the guidance, the overall performance was poor. All of the models had significant southward and slow biases (Fig. 5), moving the storm about 4 kt too slowly. Note that the model trackers had a difficult time resolving Narda, so there are fewer models than typically shown in Table 4b.

A verification of NHC official intensity forecasts for Narda is given in Table 5a. Official forecast intensity errors were generally less than the mean official errors for the previous 5-yr period. A homogeneous comparison of the official intensity errors with selected guidance models is given in Table 5b. The NHC forecast beat all of the guidance except at 36 h, which appears to be due to the first few forecasts poorly anticipating the re-strengthening of Narda offshore of western Mexico.

Coastal watches and warnings associated with Narda are shown in Table 6. Potential tropical cyclone advisories were initiated at 1500 UTC 28 September, 12 h before the system was declared a tropical cyclone, so that timely tropical storm warnings could be issued along the coast of southern Mexico.



Table 1. Best track for Tropical Storm Narda, 29 Sep–1 Oct 2019.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
28 / 1200	14.4	99.4	1004	30	disturbance
28 / 1800	14.6	99.7	1004	35	"
29 / 0000	15.1	100.1	1000	35	tropical storm
29 / 0600	16.2	100.6	999	40	"
29 / 1200	17.6	101.6	998	40	"
29 / 1400	18.0	102.0	998	40	"
29 / 1800	18.7	103.0	1000	35	"
30 / 0000	19.6	104.3	1000	35	"
30 / 0600	20.7	105.2	1000	35	"
30 / 1200	22.1	105.8	998	40	"
30 / 1800	23.6	107.3	997	45	"
01 / 0000	25.3	108.5	997	45	"
01 / 0600	26.9	109.5	1002	30	tropical depression
01 / 1200					dissipated
30 / 1800	23.6	107.3	997	45	minimum pressure and maximum winds
29 / 1400	18.0	102.0	998	40	landfall about 15 n mi northeast of Lazaro Cardenas
01 / 0000	25.3	108.5	997	45	landfall near Las Glorias, close to the mouth of the Sinaloa River

Table 2. Selected surface observations for Tropical Storm Narda, 29 Sep–1 Oct 2019.

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft)	Storm tide (ft)	Estimated Inundation (ft)	Total rain (in)
	Date/time (UTC)	Press. (mb)	Date/time (UTC)	Sustained (kt)	Gust (kt)				
Mexico									
Mazatlan International Airport (MMMZ)	30/1543	1000.7	30/1543	32 (10 min)	43				
San Blas, Nayarit (21.5N 105.3W)			30/1130		37				
Puerto Vicente, Guerrero (17.2N 101.1W)			29/NA	33 (NA)	45				
Paralelo Treinta y Ocho, Sinaloa (24.6N 107.5W)			30/2115		37				
Acapulco de Juarez (16.76N 99.75W)			29/0730		37				
Ixtapa-Zihuatenejo International Airport (MMZH)	29/1300	1003.4							

Table 3. Number of hours in advance of formation associated with the first NHC Tropical Weather Outlook forecast in the indicated likelihood category. Note that the timings for the “Low” category do not include forecasts of a 0% chance of genesis.

	Hours Before Genesis	
	48-Hour Outlook	120-Hour Outlook
Low (<40%)	78	126
Medium (40%-60%)	48	114
High (>60%)	30	78



Table 4a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Narda. Mean errors for the previous 5-yr period are shown for comparison. Official errors that are smaller than the 5-yr means are shown in boldface type.

	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL	55.2	74.9	135.4	228.3			
OCD5	85.3	157.0	294.3	507.4			
Forecasts	8	6	4	2			
OFCL (2014-18)	21.1	32.2	41.8	51.8	75.7	101.1	133.7
OCD5 (2014-18)	34.0	69.7	109.0	148.4	223.5	285.5	356.7

Table 4b. Homogeneous comparison of selected track forecast guidance models (in n mi) for Narda. Errors smaller than the NHC official forecast are shown in boldface type. The number of official forecasts shown here will generally be smaller than that shown in Table 4a due to the homogeneity requirement.

Model ID	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL	57.2	82.4	133.2	228.3			
OCD5	84.3	159.9	296.4	507.4			
GFSI	70.6	88.5	110.6	232.0			
HWFI	69.4	103.8	180.2	332.7			
AEMI	75.6	112.3	137.7	255.8			
HCCA	63.1	79.6	132.9	243.4			
TVCX	60.1	84.9	141.0	266.0			
TVCE	62.5	88.7	145.6	254.0			
TVDG	60.6	83.1	131.6	250.0			
TABD	76.1	155.6	216.4	326.1			
TABM	81.3	167.2	204.8	255.1			
TABS	102.3	224.3	302.0	381.9			
Forecasts	7	5	3	2			

Table 5a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Narda. Mean errors for the previous 5-yr period are shown for comparison. Official errors that are smaller than the 5-yr means are shown in boldface type.

	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL	7.5	9.2	8.8	5.0			
OCD5	7.5	12.3	10.8	9.0			
Forecasts	8	6	4	2			
OFCL (2014-18)	6.1	10.0	12.2	13.7	15.5	15.4	15.7
OCD5 (2014-18)	7.9	13.1	16.7	19.2	21.8	22.9	22.1

Table 5b. Homogeneous comparison of selected intensity forecast guidance models (in kt) for Narda. Errors smaller than the NHC official forecast are shown in boldface type. The number of official forecasts shown here will generally be smaller than that shown in Table 5a due to the homogeneity requirement.

Model ID	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL	7.9	8.0	6.7	5.0			
OCD5	8.0	12.4	8.3	9.0			
DSHP	9.6	8.2	1.3	11.5			
LGEM	10.1	9.6	3.3	10.5			
IVCN	9.7	8.8	4.3	10.5			
IVDR	9.1	9.0	6.3	10.5			
HWFI	8.4	14.2	7.3	16.0			
HCCA	9.7	8.6	3.3	14.0			
GFSI	8.9	13.4	18.3	20.0			
Forecasts	7	5	3	2			



Table 6. Watch and warning summary for Tropical Storm Narda, 29 Sep–1 Oct 2019.

Date/Time (UTC)	Action	Location
28 / 1500	Tropical Storm Warning issued	Acapulco to Cabo Corrientes
29 / 2100	Tropical Storm Warning discontinued	All
30 / 0300	Tropical Storm Watch issued	Topolobampo to Guaymas
30 / 0300	Tropical Storm Warning issued	San Blas to Topolobampo
30 / 0300	Tropical Storm Warning issued	Islas Marias
30 / 1500	Tropical Storm Watch discontinued	All
30 / 1500	Tropical Storm Warning modified to	San Blas to Guaymas
30 / 2100	Tropical Storm Warning discontinued	Islas Marias
1 / 0300	Tropical Storm Warning modified to	Altata to Guaymas
1 / 1200	Tropical Storm Warning discontinued	All

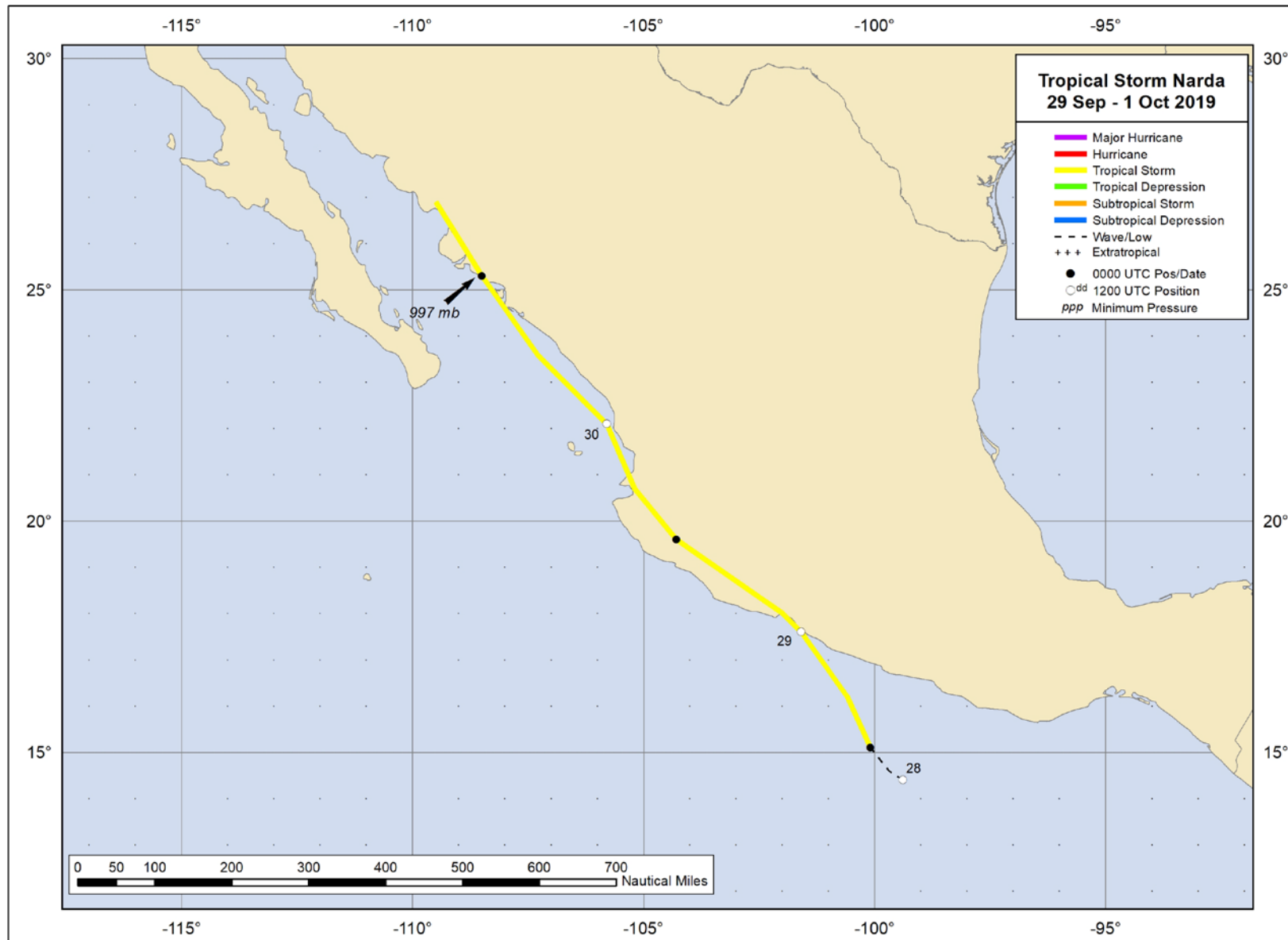


Figure 1. Best track positions for Tropical Storm Narda, 29 Sep–1 Oct 2019.

Precipitación acumulada (mm) del 27 de septiembre al 01 de octubre de 2019 por la tormenta tropical Narda

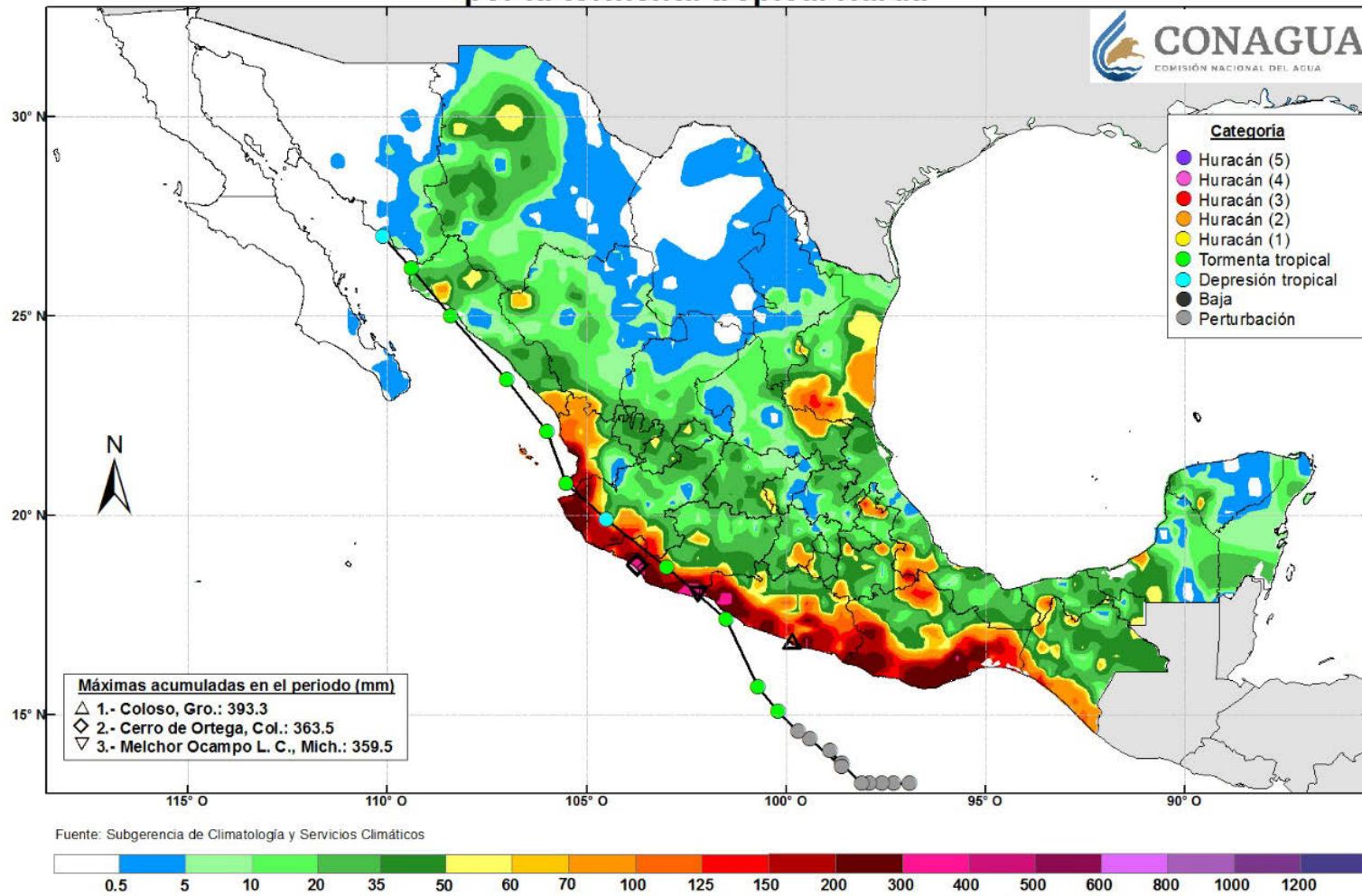


Figure 4. Accumulated precipitation (mm) from 27 September–1 October over Mexico (courtesy CONAGUA).

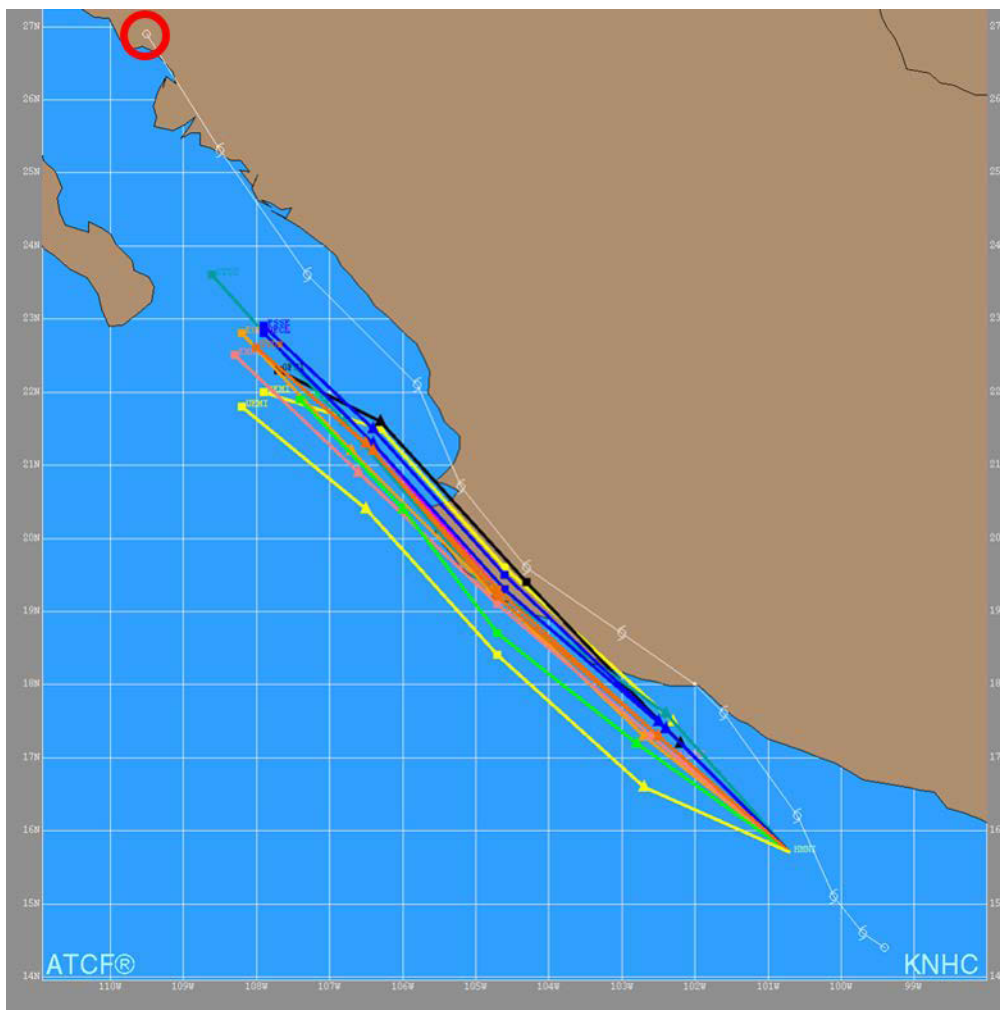


Figure 5. Selected guidance aids (colors) through 48 h and best track (white) of Narda for the 0600 UTC 29 September 2019 forecast cycle. The verifying 48-h best track point is shown by the red circle.